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DESIGN AND FABRICATION OF QUADRUPOLE ION MASS SPECTROMETER FOR --ETC(U)
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DESIGN AND FABRICATION OF QUADRUPOLE ION MASS SPECTROMETER FOR UPPER ATMOSPHERE

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Scientific Report No.1

December 1979

Approved for public release; distribution unlimited.

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: AFGL-TR-80-0024	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): DESIGN AND FABRICATION OF QUADRUPOLE ION MASS SPECTROMETER FOR UPPER ATMOSPHERE	5. TYPE OF REPORT & PERIOD COVERED: Scientific Report No. 1, Oct [redacted]77 - Sept [redacted]78
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): M. McDonald	8. CONTRACT OR GRANT NUMBER(s): F19628-78-C-0017
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Wentworth Institute of Technology, 550 Huntington Avenue, Boston, Massachusetts, 02115	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62101F, 66870 3AH
11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Geophysics Laboratory, Hanscom AFB, Massachusetts 01731, Monitor/C.A. Forsberg, LKD	12. REPORT DATE: Dec [redacted]79
	13. NUMBER OF PAGES: 13
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Quadrupole
Ion Mass Spectrometer
Gondola (Air Grab)
Liquid Helium Cryo Pump

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The material contained in this report describes in a quasi-historical format the design and fabrication of component parts and assemblies used in an Upper Atmosphere Composition Research Program conducted by the Composition Branch of the Aeronomy Laboratory, for AFGL.

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INTRODUCTION

Contract No. F19628-78-C-0017 was initiated with Wentworth Institute of Technology on 1 October 1977 by the Air Force Geophysics Research Laboratories, (AFGL) Hanscom Air Force Base, Bedford, Massachusetts, for participation in work on the Upper Atmosphere Research Program being conducted by the Air Force Systems Command of the United States Air Force. Its period of performance is three years. It is a successor to Contract No. F19628-74-C-0014 which had been in existence for substantially the same requirements and objectives during the period from 1 October 1973 to 30 September 1977. This report covers the initial year of the Contract 1 October 1977 to 30 September 1978.

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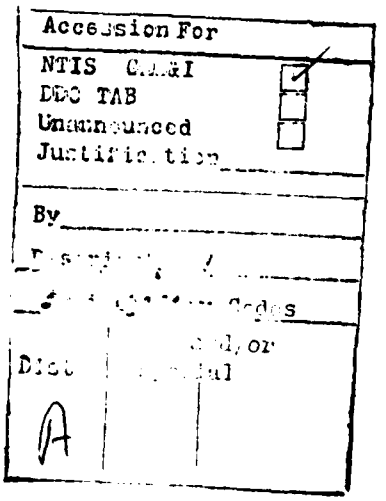

DESCRIPTION OF WORK

The objective of the Upper Atmosphere Program is the acquisition of knowledge of the physical and chemical properties of the upper atmospheric region by experimentation carried on by using instrumentation borne aloft by probing rockets and balloons.

The tasks assigned to Wentworth Institute of Technology during the first year of the contract were in support of the projects undertaken by the Composition Branch, LKD, Aeronomy Branch of the Air Force Geophysics Laboratory. These tasks involved the design, fabrication, modification, assembly and testing of instrumentation under guidelines specified by the Composition Branch. Tasks undertaken during the first year of the contract are discussed below.

One major undertaking during the first half year was the generation of a design layout of a cluster ion mass spectrometer. The initial design evolved with the help of consultations with the involved personnel at AFGL which established instrument design parameters. Assembly, subassembly and detail drawings were generated by the design section.

The cluster ion mass spectrometer consists of a two piece cone section with the top cone section electrically biased with respect to the lower cone. The front cone has an orifice opening of .03-.04" diameter for ion sampling. The cone assembly was attached to a liquid helium cooled cryo pump supplied by another contractor. Attached to the bottom side of the liquid helium cryo pump is the base plate, "O" rings provided the vacuum seal between the base plate and cryo pump. Rod housing was fixed to the base plate and extended upward through the pump section. A RF quadrupole assembly extended to the upper region of the front cone

sampling area and downward to an ion detecting electronic multiplier. An aluminum ring was externally attached to the base plate to support the electronics section of the instrument. This section consisted of a series of leg supports to which was attached a deck plate to hold an electronics oscillator box and an assortment of other housekeeping equipment. Below this deck and mechanically to it is a complex cast aluminum housing of electronic equipment. This entire section was enclosed with a vacuum tight electronic cover can. A listing of specific items made in the machine shop for this project follows:-

Quantity	Description
2	150 c.c. Sampler Cylinder (modified per sketch)
8	500 c.c. Sampler Cylinder (modified per sketch)
1	300 c.c. Sampler Cylinder (modified per sketch)
5	2" Extensions for Sampler Cylinders (per sketch)
11	End Caps for Sampler Cylinder (per sketch)
6	Feed-Thru Stand-offs
2	1" Tabulations for 8 Qt. Shpere, LKD77-64D
2	Support plates for 8 Qt. Sphere, LKD77-64D
2	Conflat Flanges for 8 Qt. Sphere LKD77-64D
6	1¼" Extension for 500 c.c. Sampler Cylinders (sketch)
1	Split Top Cover, Dewar Unit, LKD75-37D
1	Turning Fixture for Split Top Cover, Dewar Unit
1	Clamp, Dewar unit, LKD76-34D
1	Mounting Plate, LKD77-64B
1	Cone, Modified, LKD77-18D
1	Piston, LKD77-75C

1	Cylinder, LKD77-74B
4	Insulators, LKD77-73B
2	Adjusting Nuts, LKD77-72B
6	Legs, LKD77-71B
1	2½"x 1/8"Plate (per sketch)
1	2½"x .031"Plate (per sketch)
1	Aperture Plate Assembly, LKD77-78B
1	Aperture Plate Retainer, LKD77-77B
1	Ion Source Adaptor Plate (per sketch)
1	Ion Source Shield (per sketch
1	Ion Source Adaptor Plate (modified, verbal)
	Bushing and nuts (modified, verbal)
1	Top Plate, LKD77-81B
1	Bottom Plate, LKD77-82B
1	Lower Deck, LKD77-84B
1	#1 Deck, LKD77-85B
1	#2 Deck, LKD77-86B
1	Back Plate, LKD77-87B
1	Transistor Heat Sink, LKD77-90B
1	Turning Fixture, LKD-80C
2	Box Housings, LKD77-80C
1	Box Assembly
1	Electronic Support Plate, LKD77-95D
18	Support Legs (Electronic Package), LKD77-96B
6	Mounting Brackets (High Voltage Supply), LKD77-97B
2	Blow-off Nose Caps
2	Pull-off Caps, LKD78-4B
2	Pull-off Caps Modified: Added 4 tapped holes, and counter-bored slots, LKD78-4B

4	Contact Plates, LKD78-11C
4	13 Qt. Hemispheres (modified), LKD77-46D
10	8 Qt. Hemispheres (modified), LKD77-46D
2	5 Qt. Hemispheres (modified), LKD77-46D
1	Special Lab Unit Cone (modified), LKD77-18D
1	R.F. Oscillator Box Top Plate (modified), LKD77-81B
1	Assembly Fixture for Front Shock Housing and Cone Assembly, LKD78-13C
1	Protective Nose Piece for Shock Front Housing, LKD78-13C
1	Conflat Reinforcing Mtg. Plate for 5 Qt. Hemisphere
5	Conflat Reinforcing Mtg. Plate for 8 Qt. Hemisphere
2	Conflat Reinforcing Mtg. Plate for 13 Qt. Hemisphere
8	Target Insulators, LKD77-83A-1
8	Target Insulators, LKD77-83A-2
1	Shock Mount Base Plate (sketch) Added 17 C' sunk holes
32	4-40 Screws Slotted to Root Diameter (verbal)
1	Anemometer Adaptor, JON66870503 (sketch)
4	Special Adaptor Rods (per sketch)
7	Gas Surface Interface Discs for Cryo Test
1	Special Cone, LKD77-18D
3	.005" Thick Discs for Special Cone, LKD77-18D
1	Split Cover Gasket, Dewar Cooling System
7	Conflat Flanges Modified for Transport Shperes, LKD77-46D
7	2" long x 1" O.D. Tubes to fit Flanges, LKD77-46D

During the third quarter of this year tasks completed in the Drafting Section were in several areas of design, fabrication and purchasing. Design drawings were generated for an Air Snatch Gondola to be used in the Triwas Atmospheric Air Sampling Program. The Gondola was designed to accomodate the Tri-Sampler and its associated electronics equipment. Of major importance in its structural design was the integrity of the weld areas. The unit was fabricated from aluminum channel, structural angle and plate. After completion of the necessary engineering drawings the unit was fabricated, all weld areas were x-rayed and or dye penetrant checked for weld cracks. After satisfactory weld area inspections the Gondola was subjected to a heat treatment process to restore the base metal in the weld areas to its original temper. The Gondola was flown in a test flight with a simulated Tri-Sampler and electronics aboard. The flight was successfully concluded. Later, actual recovery flights showed the Gondola to be areodynamically stable during recovery operations and a reliable flight vehicle.

In the machine shop tasks continued in connection with the construction of items used in the Cluster Ion Mass Spectrometer, Mass II Mass Spectrometer and Whole Air Sampling Programs. Typical tasks completed in the shop include:

Quantity	Description
2	Pull Off Caps, modified; added tapped holes, LKD78-4B
1	Milling Fixture for Pull Off Caps, LKD78-4B
1	Grid Mandrel
4	Mounting Rings for Multiplier Housing Target Plate, LKD78 18B
1	Wire Mesh Screen Assembly

3	Grid Plates, LKD77-60B
6	Adaptor Rings, modified: LKD77-94D Machined Chamfer on O.D. 6 Tapped Holes on Face 8 Tapped Holes on Circumference Made Rotary Table Fixture for Adaptor Rings
6	Electronic Longeron Supports, Stainless Steel, LKD77-96B
6	Transformer Mounting Plates for Power Supply
1	Phenolic Electronic Longeron Support, LKD77-96B
6	Adaptor Plates, modified: LKD77-93B Added 14 Holes, Counterbored 6 Holes Re-bored I.D. to 5.187" Made Rotary Table Fixture for Plates
1	Adaptor for Vacuum System
14	Stand-offs for Multiplier Housing LKD78-5D
2	Modified Blower Housings: Removed 3 Flex Tubes from each unit Modified 6 3/4" Swage Loc Fittings to Fit Housings
3	Conflat Flanges, modified and made tubes to fit flanges Modified Cryo-lab Valve Rotatable Conflat to fit 1/4" Swage Loc Weld Adaptors
5	2 3/4" Conflat Flanges machined to fit Swage Loc unions
12	10-24 x 2½" Brass Screws necket to root diameter Bored hole in Cryo Dewar to fit Valve Body
2	Flex Tube Adaptors for Air Intake Unit
4	2 1/8" dia. Rotatable Conflats, modified to fit Flex Tubes
2	Helium fill tubes for Cryo Dewar, modified
2	150 c.c. Gas Sampler Tubes, modified
2	3.500" End Tabulations for 150 c.c. Gas Sampler Tubes

2	End Caps for 150 c.c. Gas Sampler Tubes
6	Shield Stand-offs for Cryo Dewar, modified

During the past three months revisions were made to DWG. LKD 78-5D, Electronics Can Cover of the Cluster Ion Mass Spectrometer. An undercut was removed on the outside diameter and machined on the inside diameter of the can. This revision provided additional air gap space between the inside walls of the can and the high voltage RF leads. Environmental lab tests conducted at AFGL in this area showed that a problem could develop if the RF leads were too close to the interior wall surface. In addition, one longeron support was changed to an insulating phenolic material because the high voltage RF leads in this area caused problems due to the close proximity of the metal longeron. Two electronic cans were fabricated at Wentworth Institute of Technology and delivered to AFGL along with two phenolic longeron supports. The cans mated to the Cluster Ion Mass Spectrometer electronics section satisfactorily and no misalignment was experienced.

A modification was made to the latest blow-off cap for the Cluster Ion Mass Spectrometer. This revision required an increase in the dove-tail "O" Ring Groove width by .005"to allow easier insertion of the "O" Ring into the dovetail groove. This modification was required, due to the build up of the Martin Hard Coat insulation applied to the surfaces. Detail drawings were completed on a marmon clamp, and blow-off cap designed to be used on the Lassii wide Band satellite program. These parts are presently in fabrication.

During August, field support was provided by Wentworth Institute for two balloon launches by AFGL Aeronomy Laboratory. The launch site chosen

was Watertown, South Dakota, primarily because of its mid-latitude location. Preparations went smoothly and both flights were successfully launched. A total of 5½ whole air samples were gathered out of a possible 6 samples. The field trip was extended about one week due to adverse weather conditions at launch time.

After the completion of the two launches, the two tri-samplers were loaded on a truck along with several liquid helium and nitrogen tanks for shipment to AFGL. Several days were required for the return trip to AFGL with daily transfers of liquid helium and nitrogen to the tri-samplers to keep the whole air samples cryogenically frozen.

The work completed in the Machine Shop on the Ion Cluster Mass Spectrometer is as follows:

1	Increased width of "O" Ring groove in nose blow-off cap
	Phenolic Longeron Supports, LKD77-96B
6	Squib Guides (Lassii), LKD78-32C
2	Electronic Cover Assemblies, LKD78-5D " " Fixtures
18	Spring retainers for blow-off caps
2	Marmon Clamp assemblies Lassii II, LKD78-35C Jaws have been completed. Progress on balance of assemblies stopped to allow for priority work to be completed
2	Braze adaptors modified to fit cryo-valve operators, sketch
1	Adaptor assembly for portable vacuum system, sketch

CONCLUSION

In this report no attempt has been made to detail the technical aspects of the varied processes followed in the Design Section or Machine Shop. The pertinent information was evaluated and used by the AFGL at the time of its generation. The design effort was directed by Mr. Martin McDonald and the Machine Shop output was directed by Mr. Otto Molter.